Low rehospitalization rate for vascular surgery patients

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Objectives: **Reducing rehospitalization rates has been proposed to improve care, reduce costs, and as a pay-for-performance criterion. Recent review of Medicare claims data indicates that vascular surgery patients have among the highest rates of 30-day rehospitalization at 23.9%.**

Methods: **We retrospectively examined all live patient discharges (n = 799) from the vascular surgery service at a single university hospital over 12 months. Planned and unplanned 30-day rehospitalizations were distinguished, and predictors of unplanned 30-day rehospitalization were determined. To identify whether patients were readmitted to other hospitals, a prospective study of patient discharges (n = 66) over 1 month was also performed.**

Results: **Ninety-five (11.9%) of the 799 patient discharges from the vascular surgery service were rehospitalized within 30 days. Of these, 71 were unplanned; therefore, the unplanned rehospitalization rate was 8.9%. The most common causes of unplanned 30-day rehospitalization were related to wound complications. Diabetes ($P = .039$) predicted unplanned 30-day rehospitalization by multivariate analysis. Patients with the diagnosis of critical limb ischemia (14.9%) and patients undergoing open lower extremity revascularization (14.6%) had the highest rates of unplanned 30-day rehospitalization. In the prospective portion of this study, no patient was readmitted to any other hospital.**

Conclusions: **Relatively low 30-day rehospitalization was accomplished in vascular surgery patients at a single university hospital. Moreover, planned rehospitalizations accounted for approximately 25% of readmissions in vascular surgery patients. Strategies designed to reduce rehospitalization in diabetics may be warranted. (J Vasc Surg 2011;54:767-72.)**

The rising cost of healthcare, in combination with current stresses on the healthcare framework, has led to the investigation of cost-cutting measures and methods of making the system more efficient. Reducing rehospitalization rates has been proposed as a means of improving care, reducing costs, and as a pay-for-performance criterion.[1-4] A recent review of Medicare claims data identified vascular surgery patients (as identified by diagnosis-related groups, or DRGs) as having a high rate of rehospitalization within 30 days of discharge. Vascular surgery-related DRGs accounted for the discharge diagnosis in 1.4% of all 30-day rehospitalizations. Moreover, vascular surgery had a 30-day rehospitalization rate of 23.9%, trailing only heart failure (26.9%) and psychoses (24.6%) among diagnoses for index hospitalization.[1]

That study, however, was a coarsely textured examination of rehospitalizations throughout the healthcare system, involving more than 11 million discharges over a 15-month period and left a number of questions unaddressed with respect to rehospitalization in vascular surgery patients. In particular, the estimation that 90% of rehospitalizations within 30 days of discharge are unplanned requires investigation in vascular surgery patients. By examining vascular surgery patient outcomes at a single university hospital over the course of 12 months, the current study was designed to describe rehospitalization after discharge from a vascular surgery service in a more finely-grained manner. Specifically, we sought to distinguish between planned and unplanned 30-day rehospitalization, to identify predictors of unplanned 30-day rehospitalization.[1,5-7]

METHODS

A retrospective cohort study was conducted using a prospectively-maintained database of inpatient discharges from the vascular surgery service at single university hospital between July 2008 and July 2009. The cohort consisted of patients over 18 years of age discharged from the vascular surgery service after an index inpatient admission of at least 24 hours; patients undergoing same-day surgery were not included in the study cohort.

All rehospitalizations within 30 days of inpatient discharge from the vascular surgery service at the Hospital of the University of Pennsylvania were identified and classified as planned versus unplanned. *Planned* 30-day rehospitalizations were excluded from analysis.

Predictors of unplanned 30-day rehospitalization were examined (Table I) by comparing discharges resulting in unplanned rehospitalization to discharges not resulting in

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Table I. Demographic and clinical features of index hospitalization analyzed to predict 30-day rehospitalization

Demographic and clinical features of index hospitalizations (n = 690)	
Age (years)	66.1 ± 14.7
Gender (female)	249 (36.1%)
Race[a]	
White	529 (77.8%)
African American	138 (20.3%)
Other	13 (1.9%)
Diabetes	231 (33.5%)
Weekend/holiday discharge	140 (20.3%)
Discharge[b]	
Home with self care	427 (62.0%)
Home with health service	191 (27.7%)
Rehab/skilled nursing facility	71 (10.3%)
Discharge from vascular floor	658 (95.4%)
Elective admission	490 (71.0%)
Length of stay (days)	6.0 ± 6.9
Index admitting diagnosis	
Index admitting procedure	

[a]No data for 10 patients.
[b]No data for one patient.

rehospitalization. Discharges following planned or unplanned rehospitalization were not included.

To confirm that no patients discharged from the vascular surgery service at our institution were readmitted within 30 days to other hospitals, a prospective study of patients discharged over 1 month (November 2009) was also performed. Telephone interviews of these patients were conducted to identify 30-day rehospitalization to *any* hospital. Both studies were approved by the Institutional Human Subject Review Committee.

As appropriate, Pearson χ^2 test, Student *t* test, or Mann-Whitney *U*, were used as univariate tests of each independent variable's effect on unplanned 30-day rehospitalization. Multivariate analysis was performed with logistic regression. All statistical analyses were performed using SPSS 15.0 (SPSS Inc, Chicago, Ill).

RESULTS

Of the 799 live patient discharges from the vascular surgery service, 638 discharges neither arose from nor resulted in *any* 30-day rehospitalization, 95 resulted in 30-day rehospitalization, and 66 were discharges from 30-day rehospitalizations. Of the 95 (11.9%) 30-day rehospitalization events, 24 (3.0%) were planned and 71 (8.9%) were unplanned. The Fig demonstrates freedom from planned or unplanned rehospitalization within 30 days of discharge and the number of planned and unplanned rehospitalizations by number of day after discharge. Of the unplanned rehospitalizations, 37 patients had single readmissions, 11 patients had two readmissions, and four patients sustained three readmissions. In examining potential predictors of and reasons for unplanned readmission, the 52 patient discharges that resulted in *initial* unplanned 30-day rehospitalization are compared with the 638 patient discharges that did not result in nor arise from *any* 30-day rehospitalization.

The reasons for planned 30-day rehospitalization are summarized in Table II. The most frequent reason for planned 30-day rehospitalization was elective abdominal aortic aneurysm (AAA) repair following prior admission for preoperative work-up (n = 7).

Table III lists the reasons for unplanned 30-day rehospitalization (n = 52). Thirty-three (63.5%) of the unplanned rehospitalizations were for surgical diagnoses, with approximately half of these related to wound complications. Eight patients required debridement, muscle flap coverage, or vacuum-assisted closure therapy for groin wound complications; five patients required minor amputations or debridement for non-groin wound complications; and three patients had nonhealing wounds requiring further attempts at revascularization. Thirteen patients required reintervention for graft thrombosis (n = 3), bleeding or hematoma evacuation (n = 4), or other technical complication (n = 6). Nineteen (36.5%) of the unplanned 30-day rehospitalizations were for medical diagnoses.

The demographic and clinical characteristics of patient discharges that resulted in unplanned 30-day rehospitalization (n = 52) and those that did not (n = 638) are compared in Table IV. Thirty-day unplanned rehospitalization was more common in diabetics by univariate (P = .001) and multivariate (P = .039) analysis. Of note, univariate analysis, but not multivariate analysis, demonstrated that African Americans, patients discharged to rehabilitation or skilled nursing facilities, patients with nonelective index admissions, and patients with longer index admission length of stays, were more likely to sustain unplanned 30-day rehospitalization.

In an attempt to assess the covariance of the univariate predictors of unplanned readmission, post-hoc analysis (by Pearson χ^2 test or Student *t* test as appropriate) showed that patients with diabetes were more likely to have nonelective index hospitalizations (P = .001), to be African American (P = .004), to be discharged to a rehabilitation or skilled nursing facility (P = .017), and to have longer index length of hospitalization (P = .001).

The dependence of unplanned 30-day rehospitalization on index admitting diagnosis is summarized in Table V. Patients with critical limb ischemia (14.9%) had the highest rate of unplanned 30-day rehospitalization, which was significant by univariate analysis (P = .012) but not multivariate analysis (P = .356). Discharges with the index admitting diagnosis of end-stage renal disease (ESRD) had a 6.3% unplanned 30-day rehospitalization rate. With respect to index procedure (Table VI), patients undergoing open lower extremity revascularization (14.6%) had the highest rate of unplanned 30-day rehospitalization, but this was not statistically significant by univariate (P = .055) or multivariate analysis (P = .990). In post-hoc comparisons, patients undergoing endovascular procedures had a lower 30-day rehospitalization rate than those undergoing open surgical procedures (5.0 vs 9.9%, P = .027). In addition,

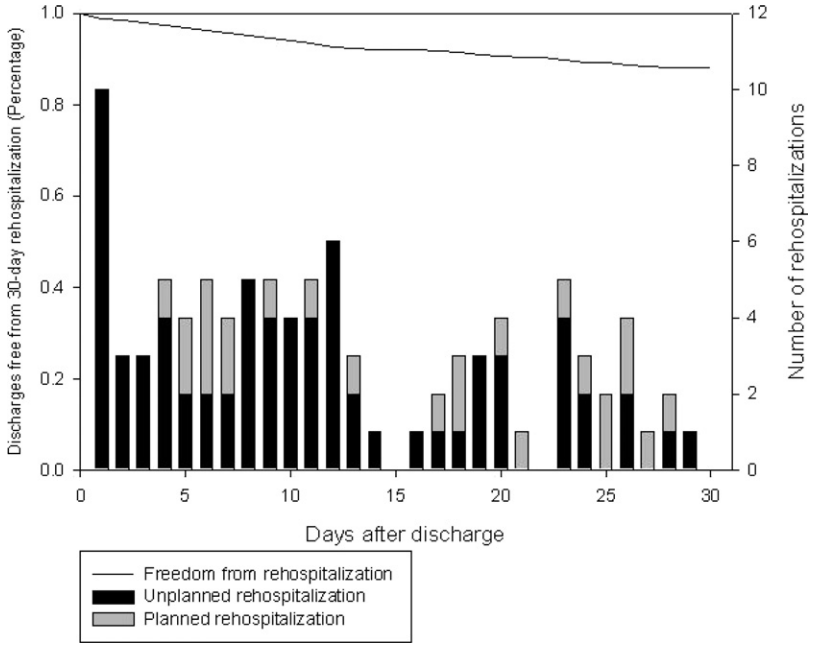

Fig. Thirty-day rehospitalization in vascular surgery patients at a single university hospital. The **left** y axis shows freedom from rehospitalization and the **right** y axis shows the number of planned and unplanned rehospitalizations.

Table II. Primary reasons for planned 30-day rehospitalization in vascular surgery patients at a single university hospital

Reason for planned readmission (n = 24)	*n (%)*
Preoperative work-up prior to elective AAA repair (CTA, stress test, etc.)	7 (29%)
Contralateral lower extremity endovascular revascularization following prior unilateral procedure	5 (21%)
Infrainguinal bypass after diagnostic arteriogram	3 (12%)
Formal amputation following distal revascularization	2 (8%)
Other staged procedures (carotid-CABG, lysis-1st rib resection, etc.)	7 (29%)

AAA, Abdominal aortic aneurysm; *CABG,* coronary artery bypass graft; *CTA,* computed tomography angiography.

patients undergoing endovascular revascularization for critical limb ischemia had a higher unplanned 30-day rehospitalization rate than patients undergoing endovascular lower extremity revascularization for claudication (12.3% vs 2.2%, $P = .028$).

In the prospective arm of the study, eight (12.1%) of 66 patients were rehospitalized within 30 days to our hospital, with four (50%) of the 30-day rehospitalizations being planned; none of the patients in the prospective part of the study were readmitted to any other hospital.

DISCUSSION

To the authors' knowledge, this is the first study to make the distinction between planned and unplanned rehospitalization and present rates of each in vascular surgery patients. The detected overall 30-day rehospitalization rate of 11.9% is substantially lower than that previously reported in the literature. Excluding planned 30-day rehospitalizations, the unplanned 30-day rehospitalization rate was 8.9%. Diabetes mellitus predicted unplanned 30-day rehospitalization. In addition, patients with the diagnosis of critical limb ischemia and patients undergoing open lower extremity revascularization had the highest rates of unplanned 30-day-rehospitalization. Lastly, planned 30-day rehospitalizations appear to comprise a significant fraction of rehospitalizations in vascular surgery patients.

The finding that diabetes predicts unplanned 30-day rehospitalization in vascular surgery patients is reasonable given the injurious effects of diabetes on wound healing and wound infection rates.[6-8] Not surprisingly, wound-related complications accounted for approximately half of the unplanned rehospitalizations with surgical problems. The prevalence of diabetes in vascular surgery patients results in a multifactorial pathophysiology, including neuropathy, infection, and ischemia that complicates the care of these patients.[9,10] In this context, the current results confirm that diabetics with vascular disease are at higher risk of complications, including unplanned 30-day rehospitalization. Improved blood sugar control postoperatively might have an impact on rehospitalization rates in these patients, and that constitutes a potential compelling prospective clinical trial.

Vogel et al analyzed 30-day outcomes in 1718 patients undergoing percutaneous transluminal angioplasty.[5] They found that patients undergoing angioplasty for claudica-

Table III. Primary reasons for initial unplanned 30-day rehospitalization in vascular surgery patients at a single university hospital

Surgical causes of unplanned 30-day hospitalization (n = 33)	*n (%)*	*Medical causes of unplanned 30-day rehospitalization (n = 19)*	*n (%)*
Reintervention for bleeding, thrombosis, pseudoaneurysm, nonhealing wound	13 (39.4%)	Infection (urinary tract infection, pneumonia, cellulitis)	5 (26.3%)
Groin wound complication	8 (24.2%)	Angina, heart failure	3 (15.8%)
Minor amputation/wound debridement	5 (15.2%)	Electrolyte disturbances requiring hemodialysis	2 (10.5%)
Major amputation	3 (9.1%)	Gastrointestinal disturbance	2 (10.5%)
Other nonhealing wound	3 (9.1%)	Stroke	1 (5.3%)
Other	1 (3.0%)	Other	6 (31.6%)

Table IV. Predictors of unplanned 30-day rehospitalization

Variable	*Unplanned 30-day rehospitalization (n = 52)*	*No unplanned 30-day rehospitalization (n = 638)*	*Univariate* P *value*	*Multivariate* P *value*
Age (mean ± SD)	63.6 ± 15.1 y	66.3 ± 14.6 y	.219	.165
Length of stay (days ± SD)	8.5 ± 8.1 d	5.8 ± 6.7 d	.006	.549
Vascular unit discharge	49 (94.2%)	609 (95.5%)	.952	.765
Day of discharge			.485	.430
Weekday	39 (75.0%)	511 (80.1%)		
Weekend	13 (25.0%)	127 (19.9%)		
Discharge[a]			.038	.661
Home, self care	24 (46.2%)	403 (63.3%)		
Home, health service	19 (36.5%)	172 (27.0%)		
Rehab/SNF	9 (17.3%)	62 (9.7%)		
Female gender	23 (44.2%)	226 (35.4%)	.262	.799
Race[b]			.015	.166
White	33 (64.7%)	496 (78.9%)		
African American	18 (35.3%)	120 (19.1%)		
Other	0 (0.0%)	13 (1.9%)		
Elective index admission	29 (55.8%)	461 (72.3%)	.018	.768
Diabetes	29 (55.8%)	202 (31.7%)	.001	.039
Index admission diagnosis	See Table V		.012	.356
Index admission procedure	See Table VI		.055	.990

[a]No information on discharge disposition in one patient.
[b]No information on race in 10 patients.

tion were younger, had less comorbidities, and had lower 30-day rehospitalization rates than patients undergoing angioplasty for rest pain or tissue loss.[5] Our results support this finding, as the unplanned 30-day rehospitalization rate in patients undergoing endovascular revascularization for claudication was significantly lower than that of patients undergoing endovascular revascularization for critical limb ischemia.

Several studies have identified racial disparities in treatment and outcomes from vascular surgery.[11-14] Rates of lower extremity amputation, and repeat lower extremity amputation, are higher among African American and Hispanic patients,[11,12] while rates of lower extremity revascularization are lower among these patients.[13] Recently, Nguyen and Henry attempted to elucidate the underlying causes of these disparities in terms of biologic and socioeconomic differences.[15] African Americans had higher rates of unplanned 30-day rehospitalization by univariate but not multivariate analysis in our study. This finding is probably explained by the higher prevalence of diabetes in African Americans in our sample.

Jencks et al[1] estimated that 10% of rehospitalizations in their study were planned. The current results suggest that may be an underestimate in vascular surgery patients, as 25.3% of 30-day rehospitalization events were planned. Distinguishing between planned and unplanned 30-day rehospitalizations would therefore appear to be important in outcomes studies of vascular surgery patients.

It is unclear why the unplanned 30-day rehospitalization rates presented in this study are lower than in the study by Jencks et al.[1] Collier showed that the use of rational clinical pathways, including a designated vascular unit, in patients who underwent major vascular procedures reduced readmission rates compared with Medicare standards.[16] Although discharge from the vascular surgery unit did not appear to protect against rehospitalization in our study, the

Table V. Unplanned 30-day rehospitalization rate by index admission diagnosis[a]

Index admission diagnosis	*Unplanned 30-day rehospitalization*
Critical limb ischemia	21/141 (14.9%)
Abdominal aortic aneurysm	9/123 (7.3%)
End-stage renal disease	2/32 (6.3%)
Claudication	6/126 (4.8%)
Asymptomatic carotid artery stenosis	2/71 (2.8%)
Symptomatic carotid artery stenosis	1/41 (2.4%)
Other	11/156 (7.1%)

[a]Univariate *P* value = .012; multivariate *P* value = .356.

Table VI. Unplanned 30-day rehospitalization rate by index admission procedure[a]

Index admission procedure	*Unplanned 30-day rehospitalization*
Open lower extremity revascularization	12/82 (14.6%)
Open abdominal aortic aneurysm repair	4/38 (10.5%)
Endovascular lower extremity revascularization	10/137 (7.3%)
Dialysis access	2/35 (5.7%)
Endovascular aneurysm repair	4/81 (4.9%)
Carotid endarterectomy	3/71 (4.2%)
Carotid angioplasty/stenting	0/36 (0.0%)
Major amputation	0/11 (0.0%)
Other or no procedure	17/198 (8.6%)

[a]Univariate *P* value = .055; multivariate *P* value = .990.

very presence of such a unit in the hospital may enforce nursing and discharge planning standards, which act to prevent the need for readmission. Fully 95.4% of the patients were, in fact, discharged from the dedicated vascular surgery unit. Another possible explanation for the low rehospitalization rate observed in this study is the very low rate of rehospitalization seen in patients with the admitting diagnosis of ESRD, which is inconsistent with the increased rate of rehospitalization associated with ESRD in other studies.[1] Of note, as the current study cohort only includes patients admitted to the hospital, it does not capture the 30-day rehospitalization rate of patients with ESRD who underwent outpatient dialysis access procedures.

A clear and anticipated limitation of the study is that 30-day rehospitalizations to other hospitals may have been missed, and therefore, the readmission rate may be underestimated. However, the prospective portion of the study, which demonstrated no outside hospital 30-day rehospitalizations and similar unplanned rehospitalization rates, would appear to validate these results. In addition, it is outside the scope of this study to compare the characteristics of our patients with those of the vascular surgery patients in the study by Jencks et al; therefore, although the demonstrated 30-day rehospitalization rate is lower than that previously reported, the reasons for this were not examined.

In conclusion, a relatively low unplanned 30-day rehospitalization rate can be accomplished in vascular surgery patients at a single university hospital. Patients with critical limb ischemia and patients undergoing open lower extremity revascularization had the highest rates of unplanned 30-day rehospitalization. Moreover, patients with diabetes are more likely to sustain unplanned 30-day rehospitalization: prospective studies and experimental interventions are warranted to attempt to reduce rehospitalizations in this group of patients. Finally, the discordance between previously published rehospitalization rates in vascular surgery patients, and those in the current study, underscores the difficulty inherent in using readmission rates as a clinical outcome measure or as a "pay-for-performance" criterion.

AUTHOR CONTRIBUTIONS

Conception and design: BJ, RF
Analysis and interpretation: BJ and DN, EW, GW, RF
Data collection: DN, LD
Writing the article: BJ, DN
Critical revision of the article: BJ, DN, EW, LD, GW, RF
Final approval of the article: All authors
Statistical analysis: BM, DN
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BM and DN contributed equally to this work.

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